

EVOLUTION OF GAS-RICH METEORITES : CLUES FROM COSMOGENIC NUCLIDES, J.N. Goswami, Physical Research Laboratory, Ahmedabad 380 009, India.

The evolution of gas-rich meteorites in general, and the setting in which the observed solar-wind, solar-flare irradiation records were imprinted in individual components of these meteorites are understood only in qualitative terms, although contrary viewpoints do exist (Goswami et al. 1984 and references therein). The regolith irradiation hypothesis, bolstered by the observations of irradiation features in lunar regolith materials, similar to those observed in gas-rich meteorites, is accepted by many workers in this field. However, a close analysis of the problem suggests that the regolith irradiation may not be the dominant mode in producing the observed precompaction irradiation features in the gas-rich meteorites.

It is generally assumed that the irradiated and non-irradiated components in the gas-rich meteorites, and particularly in the so-called 'dark-phase' material evolved together. Starting with this assumption, one can use the data on cosmogenic nuclides in gas-rich meteorites to impose strong constraints on the maximum residence time for the individual components of these meteorites within the nuclear active zone (approximately the upper meter) of the asteroidal regolith. This turns out to be $<10^5$ years in the case of CI and CM chondrites and $<10^6$ years for H-chondrites and achondrites (Goswami and Lal 1979; Goswami and Nishiizumi 1982; Goswami et al 1984; Goswami and Nishiizumi 1984). These values were obtained by considering the difference between the cosmogenic noble gas (^{21}Ne ; ^{38}Ar) and radionuclide (^{26}Al ; ^{53}Mn) exposure ages of these meteorites. Such an approach is valid as the precompaction irradiation of gas-rich meteorites must have taken place during their early evolutionary history. Although the short precompaction exposure durations for gas-rich meteorites was noted earlier by Anders (1975), this constraint was never considered explicitly in treating the problem of evolution of these meteorites. The implications of a very short ($<10^5$ years) precompaction exposure duration in the case of carbonaceous chondrites have been discussed in detail by Goswami and Lal (1979), Goswami and Macdougall (1983) and Goswami et al. (1984), which clearly show the incompatibility of the regolith irradiation scenario for these meteorites given our present understanding of asteroidal regolith dynamics (Housen et al. 1979; Langevin and Maurette 1980; Housen and Wilkening 1982a). The 'small body' irradiation model was proposed instead (Goswami and Lal 1979; Goswami et al. 1984) in which the irradiation precedes formation of the parent bodies of the carbonaceous chondrites and occur when the individual components of these meteorites were part of cm to meter-sized objects. In the case of gas-rich H-chondrites and achondrites, the time constraint imposed by cosmogenic nuclide data is barely within the limit of the regolith model (Housen and Wilkening

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1982b). However consideration of certain specific aspects, e.g. finer details of solar flare irradiation records and petrographic constraint (presence of significant fraction of gas-rich H-chondrites among all petrographic types) suggest that the regolith model may not adequately explain all these observations. Unfortunately only one achondrite (Kapoeta) and a couple of H-chondrites with high solar-wind content have been analysed in detail for their cosmogenic records (Goswami and Nishiizumi 1982; 1984). This is primarily due to the fact that saturation effect in ^{26}Al and ^{53}Mn concentrations constrain the analysis to gas-rich meteorites with exposure age < 10 m.y. In this context it will be extremely useful to use the newly developed accelerator mass-spectrometry method of determining cosmogenic ^{129}I (Nishiizumi et al. 1983) to analyse a suite of gas-rich H-chondrites with noble gas exposure age exceeding 10 m.y., and having high level of solar-wind and solar-flare irradiation. Fayetteville and Elm Creek will be two ideal candidates for such a study.

A new dimension to the problem of evolution of gas-rich meteorites was added by the recent findings of Caffee et al. (1983) that the solar flare irradiated grains in the gas-rich meteorites Kapoeta and Murchison have more than an order of magnitude higher cosmogenic ^{21}Ne in them compared to the concentrations measured in non-irradiated grains from these same meteorites. Whether this can be taken to imply an early active Sun, characterized by a harder solar flare proton spectrum, or is indicative of a very different evolutionary pathway for the irradiated components in gas-rich meteorites could be ascertained only through further work in this direction. In summary, a reappraisal of our understanding of the evolution of gas-rich meteorites is necessary considering the new inputs provided by the records of cosmogenic nuclides in these meteorites.

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